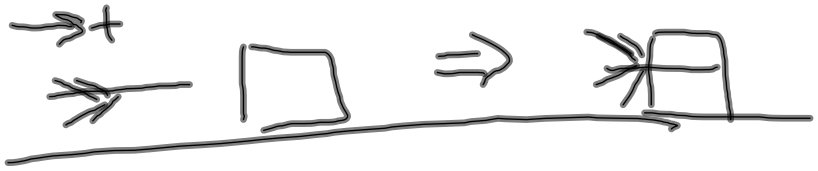
A dart has an initial velocity of 90 m/s and it collides and sticks in a stationary block (mass =10 kg). If they slide together at a velocity of 8 m/s, what is the mass of the dart?



inelastic → hit-and-stick

$$m_d \vec{v}_{di} + m_b \vec{v}_{bi} = (m_d + m_b)\vec{v}_f \qquad (\vec{v}_{bi} = \emptyset)$$

$$m_d v_{di} = m_d v_f + m_b v_f$$

$$m_d v_{di} - m_d v_f = m_b v_f$$

$$m_d (v_{di} - v_f) = m_b v_f$$

$$m_d = \frac{m_b v_f}{v_{di} - v_f}$$

$$= \frac{(10\ kg)(8\ m/s)}{(90\ m/s) - (8\ m/s)}$$

$$= 0.975\ kg$$

A 1.55 kg yellow sphere moving at 5.55 m/s to the right collides head-on with an 8.55 kg green sphere moving at 5.55 m/s to the left. After the collision, the green sphere is still moving to the left, but now with a speed of 3.25 m/s. What will the yellow sphere's velocity be after the collision?

elastic → hit and bounce

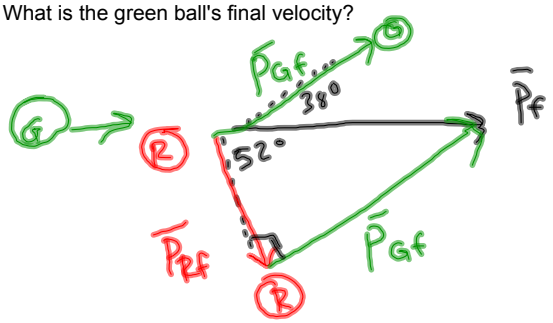
$$m_y \bar{v}_{yi} + m_G \bar{v}_{Gi} = m_y \bar{v}_{yf} + m_G \bar{v}_{Gf}$$

$$v_{yf} = \frac{1}{m_y}\left[m_y \bar{v}_{yi} + m_G \bar{v}_{Gi} - m_G \bar{v}_{Gf}\right]$$

$$= \frac{1}{1.55\,kg}\left[(1.55\,kg)(5.55\,m/s) + (8.55\,kg)(-5.55\,m/s) - (8.55\,kg)(-3.25\,m/s)\right]$$

$$= -7.14\,m/s$$

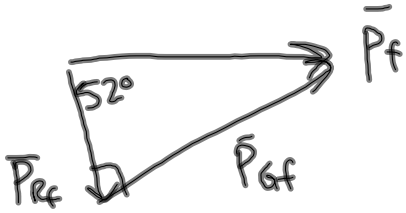
A green 3.00 kg ball moving 12.0 m/s hits a non-moving 2.00 kg red ball. After they hit, the red ball is moving to the right at a 52 degree angle from the green ball's original direction. The green ball is now moving at a 38 degree angle to the left of its original direction.
a) What is the red ball's final momentum?
b) What is the green ball's final velocity?



$$\bar{P}_i = \bar{P}_f$$

$$\bar{P}_{Gi} + \cancel{\bar{P}_{Ri}}^{\,0} = \bar{P}_f$$

$$\bar{P}_f = m_G \bar{V}_{Gi} = (3\,kg)(12\,m/s)$$
$$= 36\ kg \cdot m/s$$



a) $\bar{P}_{Rf}$? $\quad \cos(52°) = \dfrac{P_{Rf}}{P_f}$

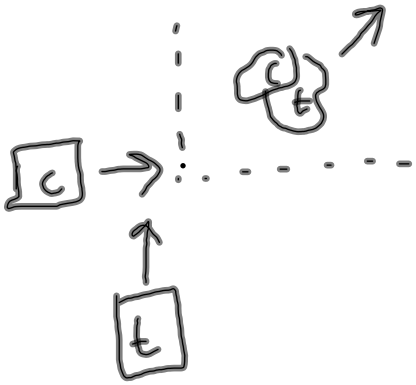
$$P_{Rf} = P_f \cos(52°)$$
$$= 22.16\ kg \cdot m/s$$

b) V_{Gf}? $\quad P_{Gf} = P_f \sin(52°)$

$$= 28.37\ kg \cdot m/s$$

$$V_{Gf} = \frac{P_{Gf}}{m_G}$$
$$= 9.46\ m/s$$

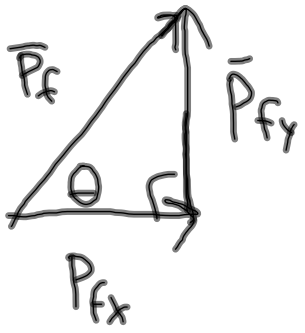
A truck is traveling north at 35 m/s and has a mass of 3000 kg. A car is traveling east at 30 m/s and has a mass of 2000 kg. If they collide and stick together, find the final velocity (magnitude, angle, direction) as they slide together.



direction is easiest part: N of E

$$P_{fx} = P_{cix} = m_c v_{cix} = 60000 \text{ kg·m/s}$$

$$P_{fy} = P_{tiy} = m_t v_{tiy} = 105000 \text{ kg·m/s}$$



Pythag. thm. to find P_f.

$$P_f = 120933 \text{ kg·m/s}$$

$$\theta = \tan^{-1}\left(\frac{P_{fy}}{P_{fx}}\right) = 60.3^\circ$$

$$P_f = (m_c + m_t) v_f$$

$$v_f = \frac{P_f}{m_c + m_t} = 24.19 \text{ m/s}$$